European Commission

NWRM

Natural Water Retention Measures

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Service contract n°07.0330/2013/659147/SER/ENV.C1

Individual NWRM

Natural bank stabilisation

ACTeon environment research & consultancy

Office International de l'Eau

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BEF LATVIA

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I.A.CO Ltd Environmental & Water Consultants

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REGIONAL ENVIRONMENTAL CENTER

REKK

SLU

SRUC

Environment

This report was prepared by the NWRM project, led by Office International de l'Eau (OIEau), in consortium with Actéon Environment (France), AMEC Foster Wheeler (United Kingdom), BEF (Baltic States), ENVECO (Sweden), IACO (Cyprus/Greece), IMDEA Water (Spain), REC (Hungary/Central & Eastern Europe), REKK inc. (Hungary), SLU (Sweden) and SRUC (UK) under contract 07.0330/2013/659147/SER/ENV.C1 for the Directorate-General for Environment of the European Commission. The information and views set out in this report represent NWRM project's views on the subject matter and do not necessarily reflect the official opinion of the Commission. The Commission does not guarantee the accuracy of the data included in this report. Neither the Commission nor any person acting on the Commission's behalf may be held responsible for the use which may be made of the information contained therein.

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I. NWRM Description

Riverbank represents both natural and artificial terrain following the river flow. In the past, lots of artificial banks were built with concrete or other types of retention walls, therefore limiting rivers' natural movements, leading to degradation of the river, increased water flow, increased erosion and decreased biodiversity. River bank renaturation consists in recovering its ecological components, thus reversing such damages and especially allowing bank to be stabilized, as well as rivers to move more freely. Nature-based solutions such as bioengineering are preferable, but civil engineering has to be used in case of strong hydrological constraints.

II. Illustration

Example of natural bank stabilisation with wood weaving (France)

Source: http://www.siave.net/Protections_berges.html

III. Geographic Applicability

Land Use	Applicability	Evidence
Artificial Surfaces	Yes	In theory, the measure can be applied to any river with artificial bank reinforcement. These may occur on rivers flowing through any type of land use.
Agricultural Areas	Yes	
Forests and Semi-Natural Areas	Yes	
Wetlands	Yes	

IV. Scale

	0-0.1km²	0.1-1.0km²	1-10km²	10-100km²	100-1000km²	>1000km²
Upstream Drainage Area/Catchment Area		✓	✓	✓	✓	✓
Evidence	This measure can be implemented on any river with artificial banks, thus with various catchment areas.					

V. Biophysical Impacts

Biophysical Impacts		Rating	Evidence
Slowing & Storing Runoff	Store Runoff	Low	The vegetation covering the banks can help storing runoff as it intercepts and infiltrates some of the rainfall.
	Slow Runoff	Low	The presence of vegetation on the banks can slow down the runoff.
	Store River Water	Low	As this measure improves the vegetation cover of the bank, it increases the capacity of the river to store water.
	Slow River Water	Medium	Replacing the concrete banks with natural vegetation helps slowing down the river flow.
Reducing Runoff	Increase Evapotranspiration	Medium	The vegetation covering the banks may increase the evapotranspiration compared to a concrete bank.
	Increase Infiltration and/or groundwater recharge	Low	Replacing concrete banks by vegetation improves the infiltration capacity of the banks, and hence increases the potential for groundwater recharge. Banks permeability may increase slightly the potentialities for infiltration but mostly are facilitating exchanges between the river and its accompanying local aquifers. Therefore the impact on infiltration is considered low.
	Increase soil water retention	Medium	The renaturalisation of banks increases the potential for soil water retention, since there is an increase in the potential for infiltration to the banks.
Reducing Pollution	Reduce pollutant sources	Low	This measure increases surface for natural filtration and biological pollutant decomposition compared to artificial banks.
	Intercept pollution pathways	Medium	The vegetation that replaces the concrete banks can better intercept the pollution that was running off the concrete directly into the river before.

Soil Conservation	Reduce erosion and/or sediment delivery	High	The stabilization of the banks with bioengineering structures and vegetation prevents the river flow from eroding the shores of the river. Several of the case studies (See Ref n°2 below) confirm that this types of changes in the river bank, and therefore activation of the typical hydromorphological processes, can lead to small scale erosion and sedimentation and the development of a broad and gently sloping bank profile. One of the actions confirmed that increased sinuosity ratio, current and variation in river width and depth lead to re-creating hydromorphological structures.
	Improve soils	High	Bank soils are greatly improved through this measure.
Creating Habitat	Create aquatic habitat	High	By slowing down the flow and giving back its natural features to the river, this measure creates aquatic habitats. There is currently little empirical evidence that bank stabilisation techniques directly benefit phytoplankton, macrophytes, benthic invertebrates and fish. However, the techniques can lead to the development of improved bank habitats, which are likely to be beneficial for macrophytes and benthic invertebrates (Clarke and Wharton, 2000; Gulickx et al., 2007). There is little evidence to suggest that phytoplankton benefit from bank rehabilitation, although the provision of high quality bank habitats and improved in-channel conditions may lead to improvements in phytoplankton habitat. Furthermore, evidence suggests that although fish populations increase when bank habitats are improved, they do not necessarily reach levels observed in natural, unmodified banks (Peters et al., 1998).
	Create riparian habitat	High	The re-introduction of riparian vegetation on the banks is a source of new riparian habitats.
	Create terrestrial habitat	Low	As this measure has little impact on the areas beyond the river banks, it may indirectly create terrestrial habitats.
Climate Alteration	Enhance precipitation	None	Nothing in this measure targets an increase in precipitation, apart from the re-introduction of natural vegetation on the banks instead of concrete that will keep the hydrological continuum going.
	Reduce peak temperature	Low	Since the vegetation can increase the evapotranspiration, the peak temperature may also be tempered by this renaturalisation of the banks.
	Absorb and/or retain CO2	Low	This measure can possibly enhance minor increase of CO2 capture in plant biomass.

VI. Ecosystem Services Benefits

Ecosystem Services		Rating	Evidence
Provisioning	Water Storage	Low	Putting the banks back to their natural features helps to improve the water storage as it slows down the flow.
	Fish stocks and recruiting	High	By creating new aquatic habitats and protecting the existent ones this measure has great potential to improve the fish stocks.
	Natural biomass production	High	Through the creation of aquatic and riparian habitats this measure increases the natural biomass production.
Regulatory and Maintenance	Biodiversity preservation	High	The creation of aquatic and riparian habitats and the preservation of existing habitats by the slowing down of the river flow preserve the biodiversity.
	Climate change adaptation and mitigation	Low	The slight reduction of peak temperature and increase in CO2 storage provided by the introduction of natural vegetation can be seen as a climate change mitigation measure.
	Groundwater / aquifer recharge	Low	The replacement of the artificial banks by natural vegetation does improve the groundwater recharge.
	Flood risk reduction	Medium	The storage of water, reduction of peak flow and slight improvement of the infiltration that this measure provides help reduce flood risks.
	Erosion / sediment control	High	By preventing the river flow from eroding the shores through a stabilized bank this measure helps the control of erosion and sedimentation.
	Filtration of pollutants	High	By storing water and helping to slow it down, as well as through the bank vegetation that can stop some pollutants, this measure increases the capacity of the river to naturally purify river water.
Cultural	Recreational opportunities	High	Diversifying the flows and introducing biodiversity can help diversify the offer of recreational activities proposed by the area.
	Aesthetic / cultural value	High	Replacing concrete by vegetation improves the aesthetic of the area.
Abiotic	Navigation	None	
	Geological resources	None	
	Energy production	None	

VII. Policy Objectives

Policy Objective		Rating	Evidence
Water Framework Directive			
Achieve Good Surface Water Status	Improving status of biological quality elements	High	This status has the potential to be improved as a result of the new habitats (aquatic and riparian) created through this measure.
	Improving status of physico-chemical quality elements	Medium	By helping the filtration of pollutants this measure has the potential to help improve the physic-chemical status of surface waters.
	Improving status of hydromorphological quality elements	High	This status is improved by the reduction of erosion and the control of sedimentation.
	Improving chemical status and priority substances	Medium	By helping the filtration of pollutants this measure has the potential to help improve the chemical status of surface waters.
Achieve Good GW Status	Improved quantitative status	Low	As natural vegetation does improve the groundwater recharge, its quantitative status may be slightly improved
	Improved chemical status	Low	As the physico-chemical status of surface waters is improved, the chemical status of the groundwater can also be improved
Prevent Deterioration	Prevent surface water status deterioration	High	The restoration of the natural features of the river banks balances the water surface through the fauna and flora.
	Prevent groundwater status deterioration	Low	The filtration of pollutants can prevent the deterioration of groundwater.
Floods Directive			
Take adequate and co-ordinated measures to reduce flood risks		Medium	This measure improves the storage capacity of the river and the infiltration towards groundwater, hence it is an adequate flood risk reduction measure. In case of flood, it also allows a better response to erosion than concrete hard banks.
Habitats and Birds Directives			
Protection of Important Habitats		High	The renaturalisation of banks creates new habitats, and preserves the existent ones.
2020 Biodiversity Strategy			
Better protection for ecosystems and more use of Green Infrastructure		High	The renaturalisation of banks creates new habitats and preserves the existent ones. It also improves the green infrastructure network

More sustainable agriculture and forestry	High	By intercepting some of the pollutants and fostering the implementation of a new riparian fauna this measure does help to improve the sustainability of agriculture and forestry.
Better management of fish stocks	High	The preservation and creation of new aquatic habitats helps a better management of fish stocks.
Prevention of biodiversity loss	High	The creation of new habitats and the diversification of the flow prevent losses of biodiversity.

VIII. Design Guidance

Design Parameters	Evidence
Dimensions	Varies depending on the river dimensions, but for large rivers may extend tens of meters on both sides of the river all along the bank.
Space required	Depends on the length of bank needing to be revitalized.
Location	All along the river, but mainly where there has previously been an artificial bank stabilization system.
Site and slope stability	The banks are usually steep, between 3:1 and 1.5:1. However this measure aims at stabilizing the banks so stability of the site is not a pre-requisite.
Soils and groundwater	There is no special condition required.
Pre-treatment requirements	There is no special condition required.
Synergies with Other Measures	Often implemented along with the following NWRM: "Revitalization of flowing waters", "Flood plain reconnection" and "Wetlands".

IX. Cost

Cost Category	Cost Range	Evidence
Land Acquisition		There is no specific information questioned in the "Cost category" from similar projects or the measure is generally implemented as a component of more complex projects and budget breakdown is not published It is assumed that natural bank stabilization is less expensive than civil engineering
Investigations & Studies		
Capital Costs		
Maintenance Costs		

Additional Costs		

X. Governance and Implementation

Requirement	Evidence
Definition of the responsibilities	The effective planning, design, and operation of this type of measure requires the involvement of a wide range of stakeholders. This include local planning authorities, environmental regulators, private companies specialized in bioengineering techniques, private landowners and land managers, farmers and other bodies with responsibilities water management (e.g. irrigation bodies, drainage boards, etc). "Involving stakeholders like farmers, fishermen and (local) citizens (during the design phase, through consultation meetings and sessions is) one the key factors of (this kind of) project"
Cost effectiveness analysis	This measure can be implemented through different solutions, with very different effectiveness. It is important to carry out beforehand an analysis of the local needs in order to choose the best bank revitalisation solution.
Monitoring	Some of the solutions would need monitoring to keep being efficient and prevent deterioration, to maintain the vegetation and the stabilisation system.

XI. Incentives supporting the financing of the NWRM

Type	Evidence
LIFE Nature and Biodiversity	Article 10 of the Habitats Directive promotes the natural rivers which are "essential for the migration, dispersal and genetic exchange of wild species"

XII. References

Reference	Comment
Restoration and Bank Stabilization Treatments and Plans, San Francisquito Creek Bank Stabilization and Revegetation Master Plan, SECTION 4: RESTORATION AND BANK STABILIZATION TREATMENTS AND PLANS, 2006	Presentation of different bank stabilization solutions.
http://your.kingcounty.gov/dnrp/library/archive-documents/wlr/biostabl/PDF/9305BnkStbCh6.pdf	Description of the role of vegetation in bank stabilization.
Gulickx, M.M.C., Beecroft, R.C. and Green, A.C. (2007) Recovery of sections of river bank using willow Salix barriers along the River Carn at Kingfishers Bridge, Cambridgeshire, England. Conservation Evidence 4, 45-48	

N10: Natural bank stabilisation

WFD and hydromorphological pressures technical report and annexes, EU, November 2006	Different case studies related to WFD and hydromorphological pressures and to the WFD best practices document. http://www.restorerivers.eu/LinkClick.aspx?fileticket=IBgquy8Es9g%3d&tabid=2624
Clarke, S.J. and Wharton, G. (2000) An investigation of marginal habitat and macrophyte community enhancement on the River Torne, UK. Regulated Rivers: Research & Management 16, 225-244.	
Gray D.H., Sotir R.B. 1996. Biotechnical and soil bioengineering slope stabilization : a practical guide for erosion control. New York (USA) : John Wiley & Sons, Inc., USA, 378 p.	Guidelines for project conception of bioengineering projects
Schiechtl H.M., Stern R., 1997. Water bioengineering techniques for watercourse bank and shoreline protection. Oxford (UK) : Blackwell, 186 p.	Guidelines for project conception of bioengineering projects
Zeh H., 2007. Ingenieurbiologie: Handbuch Bautypen. Génie biologique : Manuel de construction. Ingegneria naturalistica : Quaderno delle opere tipo. Soil bioengineering : Construction type manual. Ingenieria biologica : Manual tecnico. Vdf, 441 p.	Guidelines for bioengineering contructions
http://www.therrc.co.uk/MOT/Final_Versions_%28Secure%29/4.9_Western_Rother.pdf	Manual of river restoration techniques – Revetting and supporting riverbanks